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Cynthia Flores

Attorney Docket No.
99612Q5-US-NP

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Andrew A. Berlin

Group Art Unit: 3621

Application No.: 09/404,729

Examiner: Pierre E. Elisca

Filed: September 24, 1999

Confirmation No.: 8725

For: MARKET BASED CONTROL OF STRUCTURAL MOVEMENT

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Sir:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

LETTER

Enclosed herewith is an amended Appellants' Brief on Appeal in the above-identified application. An oral hearing is not requested.

Please charge the fee for filing of the Appeal Brief to Xerox Corporation, Deposit Account No. 24-0025.

Respectfully submitted,

Nola Mae McBain

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

1st Named Inventor:	Andrew Berlin et al.		
Assignee:	XEROX Corporation		
Title:	MARKET BASED CONTROL OF STRUCTURAL MOVEMENT		
Serial No.:	09/404,729	Filed:	09/24/1999
Examiner:	P. Elisca	Art Unit:	3621
Docket:	99612Q5-US-NP	Confirmation:	8725

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AMENDED APPEAL BRIEF

Sir:

On June 23, 2006 Appellants filed an Appeal Brief in the above-referenced application to the Board of Patent Appeals and Interferences in support of an appeal from the rejections in the Final Office Action dated December 19, 2005 in the above-referenced patent application. Appellants received a Notice of Non-Compliant Appeal Brief dated August 8, 2006 that required that an amended Appeal Brief be filed within 30 days of the Notice. Appellants hereby submit this amended Appeal Brief in response to that Notice.

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REAL PARTY IN INTEREST

The real party in interest in the subject application is Xerox Corporation, the assignee of record.

RELATED APPEALS AND INTERFERENCES

U.S. Patents 6,568,592 and 6,915,267 issued from co-owned patent applications having subject matter related to the subject matter of Application No. 09/404,729. U.S. Patent 6, 915,267 (Application No. 09/404,692) was appealed to the Board of Patent Appeals and Interferences, with a decision rendered by the Board on November 20, 2004. The Board's decision in Application No. 09/404,692 may directly affect, or be directly affected by, or have a bearing on, the Board's decision in this appeal.

The undersigned and the assignee are not aware of any other related appeals, interferences or judicial proceedings (past or present) which will directly affect, or be directly affected by, or have a bearing on, the Board's decision in this appeal.

STATUS OF CLAIMS

Claims 1 – 9 and 11 – 15 are pending in this application, of which claims 1, 4, 7 and 13 are independent claims. Claims 1 – 9 and 11 – 15 stand rejected.

The Final Office Action (dated 12/19/05) states that Claims 1 – 15 are pending and rejected in this application. However, applicants canceled claim 10 in an amendment filed on 10/18/2005, prior to the mailing of the Final Office Action. Therefore, claims 1 – 9 are pending and rejected, claim 10 is canceled, and claims 11 – 15 are pending and rejected.

Claims 1 – 9 and 11 – 15 are the subject of this Appeal. The Claims Appendix, following the Argument, provides the text of the appealed claims.

STATUS OF AMENDMENTS

Appellant has filed no amendments in the subject application subsequent to the Final Office Action mailed on December 19, 2005.

SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 and dependent claims 2 – 3 and 14 are directed to a distributed market based control assembly for applying a force to a structure. The control assembly includes multiple actuators, each of which has an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator on the structure. (Specification, page 8, lines 1 – 11; page 14, lines 5 – 21; page 22, lines 13 – 28 to page 25, lines 1 – 21; FIGS. 1, 5, 16 and 17.) The control assembly also includes an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire. The price information is represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire and is dependent on the applied force produced by each actuator on the structure. (Specification, page 4, lines 24 – 28; page 5, lines 1 – 8; pages 23 – 25.) The marketwire is connected to each actuator controller to convey the price information to the actuator controllers without requiring any one of the actuators to communicate directly with any other one of the actuators. (Specification, page 5, lines 13 – 28; page 16, lines 16 – 21.) In one embodiment of the control assembly, the analog fluctuations in the electrical characteristic of the marketwire are voltage changes. (Dependent claim 2; specification, page 12, lines 3 – 16 and FIG. 3). On another embodiment, the analog fluctuations in the electrical characteristic of the marketwire are current changes. (Dependent claim 3; specification, page 12, lines 3 – 16 and FIG. 3). In another implementation, the price information is a continuously provided electrical signal with the marketwire immediately transmitting changes in price information to the actuators. (Dependent claim 14; page 5, lines 25 – 28; see also page 6, lines 16 – 20.)

Independent claim 4 and dependent claims 5 – 6, 11 – 12 and 15 are directed to a distributed market based control assembly for a mobile structure comprising multiple actuators, each of which has an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator to collectively promote movement of the mobile structure from a first position to a second position. (Specification, page 22, lines 13 – 28; page 23, lines 1 – 13; FIGS. 16 and 17.)

The distributed market based control assembly for the mobile structure also includes a sensor for measuring the movement of the structure from the first position to the second position. The sensor produces an input measurement. (Specification, page 8, lines 1 – 11; page 22, lines 22 – 28 and FIG. 16 (sensor 270); page 24, lines 15 – 18; page 27, lines 13 - 18.) The distributed market based control assembly for the mobile structure further includes an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire. The marketwire is connected to each actuator controller and to the sensor. The price information is represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire and is dependent on the applied force produced by each actuator on the structure and on the input measurement produced by the sensor. The marketwire conveys the price information to the actuator controllers and to the sensor. (Specification, page 4, lines 24 – 28; page 5, lines 1 – 8; pages 23 – 25.) In one embodiment of the distributed market based control assembly, the analog fluctuations in the electrical characteristic of the marketwire are voltage changes, and in another embodiment, the analog fluctuations in the electrical characteristic of the marketwire are current changes. (Dependent claims 5 – 6; specification, page 12, lines 3 – 16 and FIG. 3,)

In one particular embodiment of the distributed market based control assembly for a mobile structure, the multiple actuators are air jets, and the structure is a sheet of paper. The actuator controllers are responsive to price information to control the applied forces of the air jets to collectively promote movement of the sheet of paper from a first position to the second position in a paper path. (Dependent claim 11; specification, pages 23- 25 and FIG. 16.) In another embodiment, the mobile structure is a robotic arm formed by struts interconnected by rotational elements. The actuator controllers responsive to price information control the applied forces of the multiple actuators to collectively promote movement of at least one of the struts from a first position to a second position. (Dependent claim 12; specification, page 23, lines 3 – 13 and FIG. 17.)

In one implementation of the distributed market based control assembly for a mobile structure, the assembly includes multiple sensors and each actuator controller is connected to a sensor by the marketwire. In this embodiment, the analog fluctuation in the

electrical characteristic of the marketwire caused by the input measurement produced by each sensor provides a demand level for applied forces to be produced by the actuators on the structure. The demand level is a component of the price information on the marketwire. The analog fluctuation in the electrical characteristic of the marketwire caused by the applied forces produced by the actuators on the structure provides a supply level for input measurements produced by the sensors. The supply level is also a component of the price information on the marketwire. In this implementation, operation of the actuators and the sensors is a function of the demand and supply levels seeking equilibrium. (Dependent claim 15; specification, page 11, lines 11 – 29 to page 13, lines 1 – 5.)

Independent claim 7 and dependent claims 8 and 9 are directed to a distributed market based control assembly for damping (or countering) structure movement. The elements and limitations of independent claim 7 are similar to those of independent claim 4, except that the applied forces produced by the actuators collectively counter movement of the structure, and the price information is dependent on the applied force produced by each actuator on the structure to counter the movement of the structure and on the input measurement produced by the sensor. (Specification, page 23, lines 3 – 13.)

Independent claim 13 is directed to a based control system for controlling movement of a structure comprising multiple producing units for applying forces to the structure to effect the movement, multiple consuming units for sensing the movement of the structure, and electrical conductor connecting the multiple producing units to the multiple consuming units. The operation of each of the multiple producing units and the multiple consuming units causes an analog fluctuation in an electrical characteristic of the conductor which transmits and receives market price information encoded as measurable analog fluctuations in the electrical characteristic of the conductor. The operation of the producing units to effect movement of the structure is determined in response to the market price information. (Specification, pages 23 – 25; see also pages 26 – 28 and FIG. 18.)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Whether claims 1 – 3 and 14 are patentable under 35 U.S.C. § 103(a) over the disclosure of U.S. Patent 5,999,908 issued to Abelow, in view of the disclosure of U.S. Patent 6,278,982 issued to Korhammer et al.

Whether claims 4 – 6, 11 – 12 and 15 are patentable under 35 U.S.C. § 103(a) over the disclosure of U.S. Patent 5,999,908 issued to Abelow, in view of the disclosure of U.S. Patent 6,278,982 issued to Korhammer et al.

Whether claims 7 – 9 are patentable under 35 U.S.C. § 103(a) over the disclosure of U.S. Patent 5,999,908 issued to Abelow, in view of the disclosure of U.S. Patent 6,278,982 issued to Korhammer et al.

Whether claim 13 is patentable under 35 U.S.C. § 103(a) over the disclosure of U.S. Patent 5,999,908 issued to Abelow, in view of the disclosure of U.S. Patent 6,278,982 issued to Korhammer et al.

The Final Office Action, at paragraph 3, provides a heading that indicates that the rejection of the claims is made under 35 U.S.C. § 103(a). The Final Office Action, at paragraph 4, also states that the claims "are rejected under 35 U.S.C. § 102(b) as being anticipated by Abelow in view of Korhammer." Appellants believe that the reference to 35 U.S.C. § 102(b) is an inadvertent error. Appellants assume, for purposes of this appeal, that the rejection is made under 35 U.S.C. § 103(a).

ARGUMENT

The Final Office Action rejected claims 1 – 9 and 11 – 15 under 35 U.S.C. § 103(a) as being unpatentable over the disclosure of U.S. Patent 5,999,908 issued to Abelow, in view of the disclosure of U.S. Patent 6,278,982 issued to Korhammer et al. (hereafter "Korhammer.") Appellants first present their understanding of the legal issues presented in this appeal, and then argue the patentability of independent claims 1, 4, 7 and 13 individually.

I. The Questions Presented on Appeal

The legal conclusion, that a claim is obvious within 35 U.S.C. § 103(a), depends on at least four underlying factual issues: (1) the scope and content of the prior art; (2) differences between the prior art and the claims at issue; (3) the level of ordinary skill in the pertinent art; and (4) evaluation of any relevant secondary considerations. Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 17 (1966).

Appellants believe that underlying factual issue (1) is at the crux of this appeal: Appellants disagree with the Examiner's conclusion that the Abelow and Korhammer references teach the limitations of the claims at issue in this application. While the rejection in the Final Office Action was made under Section 103 of the Patent Statute, the discussion that follows is very much rooted in a legal discussion of more closely related to anticipation law, and more specifically to whether the Examiner's interpretation of the claim language is "reasonable."

> Since it would be unreasonable for the PTO to ignore any interpretive guidance afforded by the applicant's written description, … as an initial matter, the PTO applies to the verbiage of the proposed claims the broadest reasonable meaning of the words in their ordinary usage as they would be understood by one of ordinary skill in the art, taking into account whatever enlightenment by way of definitions or otherwise that may be afforded by the written description contained in the applicant's specification.

In re Morris , 127 F.3d 1048, 44 USPQ2d 1023, (Fed. Cir. 1997). See also In re Cortright, 165 F.3d 1353, 1358 (Fed. Cir. 1999) ("Although the PTO must give claims their broadest reasonable interpretation, this interpretation must be consistent with the one that those skilled in the art would reach.").

In Cortright, the Federal Circuit looked to other patents to interpret the claim language "restore hair growth" and found the PTO's interpretation to be inconsistent with interpretations in issued patents. Prior art references may be "indicative of what all those skilled in the art generally believe a certain term means . . . [and] can often help to demonstrate how a disputed term is used by those skilled in the art" citing Vitronics Corp. v. Conceptronic, Inc. , 90 F.3d 1576, 1584, 39 USPQ2d 1573, 1578-79 (Fed. Cir. 1996). Accordingly, the PTO's interpretation of claim terms should not be so broad that it conflicts with the meaning given to identical terms in other patents from analogous art. In re Cortright, 165 F.3d at 1358. In Morris, also, the Court approved the Board's definition of claim terms consistent with their definitions in CCPA cases. In re Morris , 127 F.3d at 1056, 44 USPQ2d at 1029.

These decisions are consistent with the requirements of 37 CFR 1.104. Under the Rules of Practice, the Examiner is required to "cite the best references at his or her command" and to be specific with respect to the teachings of the cited reference as applied to the elements of each and every claim:

> 37 CFR § 1.104 Nature of examination.
>
> (c) *Rejection of claims.*
>
> . . .
>
> (2) In rejecting claims for want of novelty or for obviousness, the examiner must cite the best references at his or her command. When a reference is complex or shows or describes inventions other than that claimed by the applicant, the particular part relied on must be designated as nearly as practicable. The pertinence of each reference, if not apparent, must be clearly explained and each rejected claim specified.

It is respectfully submitted that the Final Office Action fails to follow these procedures. It will be shown below that the cited Abelow and Korhammer references are not the "best" references available. It will also be shown below that a person of ordinary skill in the art would not find the Examiner's interpretation of the language in the references to be "reasonable" when read in light of the specification, and in light of other published documents in the field of distributed control.

Moreover, the Final Office Action recites a few paragraphs of a long and complex reference (91 pages) to reject all the claims as a whole without specifying how the reference shows <u>every</u> element of <u>every</u> claim. While the Examiner may interpret the claims broadly for purposes of examination, that broad interpretation may not read out, or ignore, express limitations in Appellants' claims. The discussion below will show that some express claim limitations have simply been ignored. In addition, none of the rejections of individual dependent claims are even discussed in the Office Action.

Appellants acknowledge that 35 U.S.C. § 112 Paragraph 2 puts the burden on applicants, and not the Examiner, to precisely define the invention. As noted in <u>Morris</u>, "while it is true that the claims were not rejected on the ground of indefiniteness, this section [Section 112] puts the burden of precise claim drafting squarely on the applicant." See also <u>In re Zletz</u>, 893 F.2d 319, 322 (Fed. Cir. 1989) ("An essential purpose of patent examination is to fashion claims that are precise, clear, correct, and unambiguous. Only in this way can uncertainties of claim scope be removed, as much as possible, during the administrative process."). However, Appellants believe that the Applicant should receive, during the administrative process, some guidance as to the proper scope of his claim from the cited references that form the basis of the rejections. To Appellants, the cited Abelow reference appears to be such an unreasonable interpretation of the claim language that it provided no guidance as to how to amend the claims. Moreover, good faith efforts to amend the claims were met with the same reference in repeated Office Actions. While <u>Morris</u> correctly notes that the burden is on the Applicant, the Examiner must accept some responsibility for producing a rejection that is based on a reasonable interpretation of the claim language. *See* 37 CFR 1.104.

Appellants further believe that underlying factual issue (2) (differences between the prior art and the claims at issue) presented in Graham is also an issue in this appeal. Section 103 requires some suggestion or motivation to make the new combination. See In re Rouffet, 149 F.3d 1350, 1355-56 (Fed. Cir. 1998). Appellants will show that a person of ordinary skill in the art would not be motivated to make the asserted combination on the basis of the rationale provided in the Final Office Action.

In brief, then, the discussion that follows will show that the Abelow and Korhammer references cited in the Office Action of December 19, 2005 fail to teach any of the elements of the claims, and that the motivation for making the asserted combination is flawed. Therefore, the Examiner has not made a *prima facie* case for a rejection under 35 USC § 103(a) based on these references.

II. The Final Office Action fails to state a prima facie case of obviousness under 35 U.S.C. § 103(a) with respect to claims 1 – 3 and 14.

A. The Office Action does not recite teachings for all elements in Claim 1.

Table 1 below shows the claim elements of claim 1, along with the portions of the Abelow and Korhammer references that are recited in the Office Action as teaching the claim elements. Since the Office Action does not address the elements of independent claim 1 individually, the recited portions from the references are "assigned" to claim elements as best can be understood from the Office Action.

Table 1: Claim 1 and Recited teachings from Abelow, Korhammer References

Claim Element	Recitation
A distributed market based control assembly for applying a force to a structure comprising	No specific recitation.
multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator on the structure; and	**Abelow, col. 2, lines 13 – 27**: "This Customer-Based Product Design Module invention uses a combination of computer hardware, software and communications technologies to construct module that is built into certain products and services, to establish a network of customer-vendor-distributor interactions and communications (or a network of internal organization-wide interactions in the area of computer-based performance). These make possible new customer and user roles in the design and development of products and services, and customer-vendor relationships. Over time, this may produce a gradual transfer to customers of commercial direction and market control both in individual cases (such as the evolution of a particular product) and in aggregate, from vendors and distributors."
an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire;	**Abelow, col. 76, lines 61 – 65**: "The present invention may provide many types of specialized feedback systems from customers and markets by enabling them to "talk back" to products, so that specific audiences at vendor companies may accomplish their objectives better than is currently possible, such as:…"
the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire;	**Abelow, col. 76, lines 61 – 65 (text above.) and col. 70, lines 60 – 11** (possibly meant to extend to col. 71, line 11?): "…homes will produce an enormous expansion in the products and services that may be marketed and delivered over networks. In this context, which is the emergence of networked societies and economies, this invention is more than just a reflection of the financial needs of Vendors to increase revenues and profits. It can also be seen as a reflection of the emerging beliefs, assumptions, and values of such a networked society or economic system. The fundamental change is for Customers to assist in providing the

NOTE: in the Office Action, the Examiner first states that the element " the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire" is taught by Abelow, and provides a citation.	vendor's conscious decision making function; they help choose the nature of the products and services they prefer and the features they want included or excluded. Thus, the transition proposed here is to interactive products that are actively shaped by the conscious and self-chosen needs, demands and constraints of the people and organizations that use them. The eventual result could be that products and services are manufactured based on active preferences, beliefs and values that emerge (at least in part) from the people who buy and use them, as a normal feature of product use."
Then, the Examiner states that Abelow does <u>not</u> teach this element, and that Kornhammer provides the requisite teaching..	**Kornhammer, Abstract:** "A securities trading consolidation system where each customer uses a single trader terminal to view, and analyze security market information from and to conduct security transactions with two or more ECNs, or other comparable ATSs, alone or in combination with one or more electronic exchanges. A consolidating computer system supplies the market information and processes the transactions. The consolidating computer system aggregates order book information from each participating ECN order book computer including security, order identification, and bid/ask prices information. Bid and ask prices for participating electronic exchanges may be integrated into the display. The combined information is displayed to a customer by security and by bids and offers, and then sorted by price, volume and other available attributes as desired by the customer. The consolidating computer system forwards to each trading terminal information from only those market maker ECNs and electronic exchanges that the customer is an ECN member or electronic exchange user and thus entitled to receive. **Kornhammer, col. 3, lines 6 – 31:** Given the closed nature of individual ECNs, there are substantial fluctuations between the prices being offered within each ECN and between ECNs. In an attempt to solve the problem, SEC's Limit Order Rule requires each conforming ECN to display its inside market on electronic exchanges such as NASDAQ. The inside market data is displayed and accessed by users of the electronic

	exchange network. Such an ECN is a conforming ECN integrated with the exchange. An ECN will not receive NASDAQ quotes, but ECN members may receive this data if they are broker dealers. Integrating ECNs and their inside market data with electronic exchanges only solves part of the existing market's fragmentation. A non-member of an integrated ECN only has access to the ECN's inside prices and may only execute upon them. Without membership in an ECN, i.e., a direct connection to the ECN, a user of an electronic exchange must use the electronic exchange as an intermediary to observe fluctuation in the ECN's inside market. Having to use an intermediary to an ECN will result in data transmission delays compared to members of the ECN who have direct access to the ECN's network. Finally when a trade is made by an ECN member through NASDAQ or a similar electronic exchange or by an electronic exchange user through the ECN, he/she usually pays two fees, one to the ECN and one to the electronic exchange.
the price information being dependent on the applied force produced by each actuator on the structure;	There does not appear to be a specific recitation for this element. (Recitations of Abelow, col. 1, lines 56 – 67 and col. 2, lines 1 - 5 are referenced with respect to the "sensor" element of claims 4 and 7.
the marketwire being connected to each actuator controller to convey the price information to the actuator controllers without requiring any one of the actuators to communicate directly with any other one of the actuators.	No specific recitation found.

As shown in Table 1, the Examiner recites no teaching, in either reference, for the claim limitation of "the price information being dependent on the applied force produced by each actuator on the structure." The Examiner also recites no teaching for the claim element "the marketwire being connected to each actuator controller to convey the price information to the actuator controllers without requiring any one of the actuators to communicate directly with any other one of the actuators."

B. The Examiner's interpretation of the claim language in Claim 1 is not "reasonable."

1. The interpretation of the term "actuator."

The Office Action states at Page 2 that the claim element of "multiple actuators" is taught by the teaching in the Abelow reference at col.2, lines 13 – 17 as meaning "computer hardware, software and communications technologies to construct a module that is built into certain products and services, to establish a network."

Appellants submit that the Examiner's interpretation of "actuators" as "computer hardware, software and communications technologies ... to establish a network" is not reasonable when viewed in light of the specification, and this interpretation would not be consistent with the one that those skilled in the art would reach. Appellants submit that a more "reasonable" interpretation of "actuators" is found, for example, in US 6,560,493, entitled "Architecture for distributed control of actuator and sensor arrays," filed on February 26, 1999. Appellants submitted the '493 patent in an Information Disclosure Statement in August, 2003. Appellants submit that this reference presents a usage of the term "actuator" that is more reasonable to a person of ordinary skill in the art. For example, in the Background, the '493 patent states:

> "In various control engineering applications, it is desired to regulate some physical variable throughout the length, area, or volume of a medium. Examples can include elimination of vibration in flexible, solid material structures, disturbance elimination in fluid flow, uniform temperature regulation throughout a fluid pool, etc. Until recently, the typical interface between the medium and the controller consisted of a relatively small number of sensors and actuators at fixed locations. The sensors continuously monitor the actual state of the relevant physical variables at their respective locations while the actuators continuously act in real time on the medium in response to controller logic. The controller, which typically comprises a microprocessor, determines the appropriate action on the basis of the sensor readings, predetermined control objectives, and the

> control algorithm logic.
> Recent advancements in micro-electro-mechanical systems (MEMS) have produced microscopic devices with actuating, sensing, computing, and/or telecommunication capabilities. It is preferred to distribute a large array of MEMS in a spatial configuration in order to enhance capabilities for control. ...
> However, the increased distribution of MEMS throughout a medium to be controlled has created certain control problems. For example, the current speed and memory capabilities of microprocessors are insufficient to process the multiplicity of sensor readings and control the actuators in a meaningful fashion.

Appellants also submitted in an Information Disclosure Statement a non-patent literature reference by Guenther, et al. entitled "Controls for Unstable Structures," published in 1997. This document also references distributed control organizations for sensors and actuators. Appellants respectfully submit that these two representative examples of published references may be interpreted as indicating the knowledge of an ordinary person of skill in the art at the time this application was filed, and that, in view of these references, such a person of ordinary skill would <u>not</u> find the Examiner's interpretation of Abelow and Kornhammer as being "reasonable."

Even if one were to accept that Abelow teaches a "network of actuators," it would be reasonable to conclude that each of the "actuators" in the network communicate directly with each other. In fact, Abelow appears to disclose such communication, at col. 2, lines 27 – 36:

> [o]ne of the core purposes of the invention is illustrated in FIG. 15. This is the ability to learn interactively and iteratively from the users of products and information systems anywhere in the world while they are in use--without having to travel to their sites (or without having to bring them to a testing laboratory). Since this is a two-way link, it also offers the ability to

respond meaningfully to customers and users based on worldwide, local, organizational or individual needs regardless of where they are located.

However, claim 1 also includes the limitation "the marketwire being connected to each actuator controller to convey the price information to the actuator controllers without requiring any one of the actuators to communicate directly with any other one of the actuators." Thus, even if it is reasonable to interpret Abelow as teaching a "network of actuators," it would not be reasonable to conclude, on the basis of the passage cited above, that Abelow teaches the limitation cannot be cited for teaching the limitation "without requiring any one of the actuators to communicate directly with any other one of the actuators."

2. <u>The interpretation of the term "price information."</u>

The term "price" is used in the element of Claim 1 that reads "the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire." The marketwire is an electrical conductor, and price information is represented by analog fluctuations in an electrical characteristic of the electrical conductor.

The Office Action states at Page 3 that the claim element of "price information" may be provided by "specialized feedback systems" as taught by the teaching in Abelow at col. 76, lines 61 – 65, or by Korhammer (Abstract, and col. 3, lines 6 – 31.) The Examiner appears to be interpreting the term "price" as used in Claim 1 literally. The passage in Kornhammer talks about "substantial fluctuations between the prices being offered within each ECN and between ECNs" as teaching this element. Appellants submit that a more reasonable interpretation of Kornhammer is that these prices refer to the monetary prices of <u>securities, such as stocks</u>, since "ECN" stands for electronic communication network, or electronic exchange. (See Kornhammer, col. 1, lines 7 – 13.) These "prices" cannot be reasonably interpreted to mean "analog fluctuations in an electrical characteristic of the electrical conductor."

C. <u>The Final Office Action fails to provide a rational motivation to combine the two references.</u>

The Office Action states that it would have been obvious to a person of ordinary skill in the art at the time the invention was made "to modify the product distribution of Abelow by including the limitation detailed above as taught by Kornhammer because this would determine the occurrence of certain types of market events." Office Action, page 3. Presumably, the "limitation detailed above" refers to the limitation that the "price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire."

As noted above, the "prices" referenced in Kornhammer cannot be reasonably interpreted to mean "analog fluctuations in an electrical characteristic of the electrical conductor." However, even if such an interpretation was warranted, if Abelow does not teach this limitation, then presumably, according to the Examiner's rationale, Abelow would be modified by the teaching of Kornhammer to <u>introduce</u> price fluctuations to meet the requirements of the claim language. Abelow is concerned with two-way interactive communications between customers and product developers, and between product developers and third parties such as vendors. (Abelow, Abstract.) Abelow mentions that information gathered from customers might include price (col. 42, lines 35 – 40), and that users may sell their data at a certain price (col. 44, lines 35 – 48). The Examiner provides no reason to <u>introduce</u> price fluctuations into the sales price of products or of user data.

Moreover, Appellants submit that Kornhammer reference refers to price fluctuations between ECNs as a "problem" (see col. 3, lines 6 – 10) and not as a desirable feature.

For the foregoing reasons, it is respectfully submitted that a person of ordinary skill in the art would not look to the Kornhammer reference for a way to modify the product development and distribution described in Abelow in order to introduce "price fluctuations." The motivation to make the combination cited in the Office Action is simply not reasonable.

In view of the Examiner's unreasonable interpretation of Appellants' claim language, the Examiner has failed to show where the cited references teach each and every claim limitation of independent claim 1, and has failed to provide the motivation to make the asserted combination. Since dependent claims 2, 3 and 14 include the limitations of claim 1, claims 2, 3 and 14 are also not obvious. Appellant respectfully request reversal of the rejection of claims 1 – 3 and 14.

III. The Final Office Action fails to state a prima facie case of obviousness under 35 U.S.C. § 103(a) with respect to claims 4 – 6, 11 – 12 and 15.

A. The Office Action does not recite teachings for all elements in Claim 4.

Table 2 below shows the claim elements of independent claim 4, along with the portions of the Abelow and Korhammer references that are recited to teach the claim elements. Since the Office Action does not address the independent claims individually, the recited portions from the references in Table 2 are identical to those in Table 1, as best can be understood from the Office Action. Where the text of the two references has been previously presented in Table 1, it is not repeated here, for brevity.

Table 2: Claim 4 and Recited teachings from Abelow, Korhammer References

Claim Element	Recitation
A distributed market based control assembly for a mobile structure comprising:	No specific recitation.
multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator to collectively promote movement of a structure from a first position to a second position,	**Abelow, col. 2, lines 13 – 27**: (See text in Table 1.)
a sensor for measuring the movement of the structure from the first position to the second	**Abelow, col. 1, lines 56 – 67, col. 2, lines 1 – 5**: "In a growing number of product categories and

position, the sensor producing an input measurement; and;	industries one key to success is improving the full range of outcomes required by customers for their success. For example, the entire computing industry has been judged harshly for failing to significantly improve productivity measures. Similarly, the medical industry struggles to learn how to provide quality care with a lower cost-per-patient outcome. Such transformations in performance require simultaneous improvements by vendors, customers and everyday product users, which requires systemic and systematic measurement and dynamic adaptation across products, organizations, industries, markets and societies."
an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire; the marketwire being connected to each actuator controller and to the sensor;	**Abelow, col. 76, lines 61 – 65**: (See text in Table 1.)
the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire; NOTE: in the Office Action, the Examiner first states that this element is taught by Abelow, and provides a citation. Then, the Examiner states that Abelow does <u>not</u> teach this element, and that Kornhammer does.	**Abelow, col. 76, lines 61 – 65 (text above.) and col. 70, lines 60 – 11** (possibly meant to extend to col. 71, line 11?): (See text in Table 1.) **Kornhammer, Abstract:** **Kornhammer, col. 3, lines 6 – 31:** (See text in Table 1.)
the price information being dependent on the applied force produced by each actuator on the structure and on the input measurement produced by the sensor;	There does not appear to be a specific recitation for this element.
the marketwire being connected to each actuator controller and to the sensor; the marketwire conveying the price information to the actuator controllers and to the sensor.	No specific recitation found.

As shown in Table 2, the Examiner recites no teaching, in either reference, for the claim limitation of "the price information being dependent on the applied force produced by each actuator on the structure and on the input measurement produced by the sensor." The Examiner also recites no teaching for the claim element "the marketwire being connected to each actuator controller and to the sensor; the marketwire conveying the price information to the actuator controllers and to the sensor."

In addition, the interpretation of the references in the Office Action appear to ignore the limitation in claim 4 that the price information "controls an applied force produced by the actuator to collectively promote movement of a structure from a first position to a second position." If the multiple actuators are interpreted to mean the network of computer hardware, software and communications technologies, it does not appear that Abelow provides a teaching that these entities apply a force to "collectively promote movement of a structure from a first position to a second position,"

B. <u>The Examiner's interpretation of the claim language in Claim 4 is not "reasonable."</u>

The arguments presented above with respect to the interpretation of the "actuator" and "price" elements in Claim 1 also apply to Claim 4.

The Office Action notes that "productivity measures is readable as a sensor," reciting col. 1, lines 56 – 67 and col. 2, lines 1 – 5 of Abelow, which mentions productivity measures, as teaching the limitation of a sensor. Appellants again point to US 6,560,493 and the Guenther reference, the two examples of published references mentioned above, both of which discuss "sensors." Appellants reiterate that that these published references may be interpreted as indicating the knowledge of an ordinary person of skill in the art at the time this application was filed. In view of these references, such a person of ordinary skill would not find the Examiner's interpretation of "productivity measures" in Abelow as providing a "reasonable" interpretation of the term "sensor."

C. <u>The Final Office Action fails to provide a rational motivation to combine the two references.</u>

For the reasons noted above with respect to Claim 1, it is respectfully submitted that a person of ordinary skill in the art would not look to the Kornhammer reference for a way to modify the product development and distribution described in Abelow in order to introduce "price fluctuations." The motivation to make the combination cited in the Office Action is simply not reasonable.

In view of the Examiner's unreasonable interpretation of Appellants' claim language, the Examiner has failed to show where the cited references teach each and every claim limitation of independent claim 4, and has failed to provide the motivation to make the asserted combination. Since dependent claims 5, 6 and 15 include the limitations of claim 4, claims 5, 6 and 15 are also not obvious.

D. The Rejection of Dependent Claims 11 and 12.

The Office Action does not provide cited passages in either Abelow or Kornhammer that show the teaching of the elements of dependent claims 11 and 12, and so Appellants assert that the Examiner has not made a *prima facie* case of rejection under 35 U.S.C. §103 for these claims.

Claim 11.

Claim 11 depends from claim 4 and states that the multiple actuators are air jets, and the structure is a sheet of paper. The actuator controllers are responsive to price information to control the applied forces of the air jets to collectively promote movement of the sheet of paper from a first position to the second position in a paper path.

Appellants submit that neither the Abelow nor Kornhammer disclosures teach that air jet actuators move sheet of paper from a first position to the second position in a paper path.

Claim 12.

Claim 12 depends from claim 4 and states that the mobile structure is a robotic arm formed by struts interconnected by rotational elements, and that the actuator controllers

responsive to price information control the applied forces of the multiple actuators to collectively promote movement of at least one of the struts from a first position to a second position.

Appellants submit that neither the Abelow nor Kornhammer disclosures teach that actuators move at least one of the struts of a robotic arm from a first position to the second position.

Appellant respectfully request reversal of the rejection of claims 4, 5, 6, 11, 12 and 15.

IV. The Final Office Action fails to state a prima facie case of obviousness under 35 U.S.C. § 103(a) with respect to claims 7 – 9.

A. The Office Action does not recite teachings for all elements in Claim 7.

Table 3 below shows the claim elements of independent claim 7, along with the portions of the Abelow and Korhammer references that are recited to teach the claim elements. Since the Office Action does not address the independent claims individually, the recited portions from the references in Table 3 are identical to those in Table 1, as best can be understood from the Office Action. All of the text of the two references has been previously presented in Table 1, and so it is not repeated here, for brevity.

Table 3: Claim 7 and Recited teachings from Abelow, Korhammer References

Claim Element	Recitation
A distributed market based control assembly for damping structure movement comprising:	No specific recitation.
multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator to collectively counter movement of a structure from a first position to	**Abelow, col. 2, lines 13 – 27**: (See text in Table 1.)

a second position,	
a sensor for measuring the movement of the structure from the first position to the second position, the sensor producing an input measurement; and;	**Abelow, col. 1, lines 56 – 67, col. 2, lines 1 – 5**: (See text in Table 1.)
an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire; the marketwire being connected to each actuator controller and to the sensor;	**Abelow, col. 76, lines 61 – 65**: (See text in Table 1.)
the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire; NOTE: in the Office Action, the Examiner first states that this element is taught by Abelow, and provides a citation. Then, the Examiner states that Abelow does <u>not</u> teach this element, and that Kornhammer does.	**Abelow, col. 76, lines 61 – 65 (text above.) and col. 70, lines 60 – 11** (possibly meant to extend to col. 71, line 11?): (See text in Table 1.) **Kornhammer, Abstract:** **Kornhammer, col. 3, lines 6 – 31:** (See text in Table 1.)
the price information being dependent on the applied force produced by each actuator on the structure to counter movement of the structure and on the input measurement produced by the sensor;	There does not appear to be a specific recitation for this element.
the marketwire being connected to each actuator controller and to the sensor; the marketwire conveying the price information to the actuator controllers and to the sensor without requiring any one of the actuators to communicate directly with the sensor.	No specific recitation found.

As shown in Table 3, the Examiner recites no teaching, in either reference, for the claim limitation of "the price information being dependent on the applied force produced by each actuator on the structure to counter movement of the structure and on the input measurement produced by the sensor." The Examiner also recites no teaching for the claim element "the marketwire being connected to each actuator controller and to the

sensor; the marketwire conveying the price information to the actuator controllers and to the sensor without requiring any one of the actuators to communicate directly with the sensor."

Moreover, the interpretation of the references in the Office Action appear to ignore the limitation in claim 7 that the price information controls "an applied force produced by the actuator to collectively counter movement of a structure from a first position to a second position." If the multiple actuators are interpreted to mean the network of computer hardware, software and communications technologies, it does not appear that Abelow provides a teaching that these entities apply a force to "collectively counter movement of a structure from a first position to a second position."

B. <u>The Examiner's interpretation of the claim language in Claim 7 is not "reasonable."</u>

Appellants request that Board consider the arguments presented above with respect to the interpretation of the "actuator" "price" and "sensor" elements in the discussions of Claims 1 and 4, as they also apply to Claim 7.

C. <u>The Final Office Action fails to provide a rational motivation to combine the two references.</u>

For the reasons noted above with respect to Claim 1, it is respectfully submitted that a person of ordinary skill in the art would not look to the Kornhammer reference for a way to modify the product development and distribution described in Abelow in order to introduce "price fluctuations." The motivation to make the combination cited in the Office Action is simply not reasonable.

In view of the Examiner's unreasonable interpretation of Appellants' claim language, the Examiner has failed to show where the cited references teach each and every claim limitation of independent claim 7, and has failed to provide the motivation to make the asserted combination. Since dependent claims 8 and 9 include the limitations of claim 7, claims 8 and 9 are also not obvious.

Appellant respectfully request reversal of the rejection of claims 7 – 9.

V. <u>The Final Office Action fails to state a prima facie case of obviousness under 35 U.S.C. § 103(a) with respect to claim 13.</u>

The Office Action makes no specific reference to Claim 13, and so does not recite where the Abelow or Kornhammer references may teach the elements of the claim. For example, the Office Action makes no specific reference to the language in Claim 13 of "producing units" and "consuming units." The Office Action also does not provide any citations in the references for the teaching of the claim limitation "the electrical conductor transmitting and receiving market price information encoded as measurable analog fluctuations in the electrical characteristic of the conductor."

The Office Action also does not provide any citations in the references for the teaching of the claim limitation "operation of each of the multiple producing units and the multiple consuming units causing an analog fluctuation in an electrical characteristic of the conductor." Moreover, the interpretation of the references in the Office Action appear to ignore the limitation in claim 13 that "operation of the producing units to effect movement of the structure being determined in response to the market price information." If the multiple producers are interpreted to mean the network of computer hardware, software and communications technologies as taught in Abelow, it does not appear that Abelow provides a teaching that these entities "effect movement of the structure,"

Appellants submit that the claim language of claim 13 is sufficiently different form the language in independent claims 1, 4 and 7 that claim 13 warrants specific discussion in the Office Action. Such discussion is missing and Appellants decline to speculate how the Examiner intended to apply the recitations of the references listed in Tables 1 – 3 to the language in claim 13.

The Final Office Action also fails to provide a rational motivation to combine the two references. For the reasons noted above with respect to Claim 1, it is respectfully submitted that a person of ordinary skill in the art would not look to the Kornhammer

reference for a way to modify the product development and distribution described in Abelow in order to introduce "price fluctuations." The motivation to make the combination cited in the Office Action is simply not reasonable.

In view of the lack of any specific discussion of Claim 13 in the Office Action, the Examiner has failed to show where the cited references teach each and every claim limitation of independent claim 13, and has failed to provide the motivation to make the asserted combination.

Appellant respectfully request reversal of the rejection of claim 13.

CONCLUSION

In view of the discussion and arguments presented above, Appellant respectfully submits that the Final Office Action has failed to state a *prima facie* case of obviousness under 35 U.S.C. § 103(a) with respect to claims 1 – 9 and 11 – 15. Appellant further submits that claims 1 – 9 and 11 – 15 are patentably distinguishable over the combination of the Abelow and Korhammer references. Appellant requests that the Board reverse the rejections to claims 1 – 9 and 11 – 15.

Respectfully submitted,

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Dated: Sept. 8, 2006

CLAIMS APPENDIX

Claim 1: A distributed market based control assembly for applying a force to a structure comprising:

multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator on the structure; and

an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire; the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire; the price information being dependent on the applied force produced by each actuator on the structure; the marketwire being connected to each actuator controller to convey the price information to the actuator controllers without requiring any one of the actuators to communicate directly with any other one of the actuators.

Claim 2: The distributed market based control assembly for a structure of claim 1, wherein the analog fluctuations in the electrical characteristic of the marketwire are voltage changes.

Claim 3: The distributed market based control assembly for a structure of claim 1, wherein the analog fluctuations in the electrical characteristic of the marketwire are current changes.

Claim 4: A distributed market based control assembly for a mobile structure comprising:

multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator to collectively promote movement of a structure from a first position to a second position,

a sensor for measuring the movement of the structure from the first position to the second position, the sensor producing an input measurement; and

an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire; the marketwire being connected to each actuator controller and to the sensor; the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire; the price information being dependent on the applied force produced by each actuator on the structure and on the input measurement produced by the sensor; the marketwire conveying the price information to the actuator controllers and the sensor.

Claim 5: The distributed market based control assembly for a mobile structure of claim 4, wherein the analog fluctuations in the electrical characteristic of the marketwire are voltage changes.

Claim 6: The distributed market based control assembly for a mobile structure of claim 4, wherein the analog fluctuations in the electrical characteristic of the marketwire are current changes.

Claim 7: A distributed market based control assembly for damping structure movement comprising:

multiple actuators, each of the multiple actuators having an actuator controller that is responsive to an electrical signal representative of price information to control an applied force produced by the actuator to collectively counter movement of a structure from a first position to a second position,

a sensor for measuring movement of the structure from the first position to the second position, the sensor producing an input measurement; and

an electrical conductor for transmitting voltage and accumulating charge, referred to as a marketwire; the marketwire being connected to each actuator controller and to the sensor; the price information being represented on the marketwire by analog fluctuations in an electrical characteristic of the marketwire; the price information being dependent on the applied force produced by each actuator on the structure to counter the movement of the structure and on the input measurement produced by the sensor; the marketwire conveying the price information to the actuator controllers and the sensor without requiring any one of the actuators to communicate directly with the sensor.

.

Claim 8: The distributed market based control assembly for damping structure movement of claim 7, wherein the analog fluctuations in the electrical characteristic of the marketwire are voltage changes.

Claim 9: The distributed market based control assembly for damping structure movement of claim 7, wherein the analog fluctuations in the electrical characteristic of the marketwire are current changes.

Claim 10: (canceled)

Claim 11: The distributed market based control assembly for a mobile structure of claim 4, wherein the multiple actuators are air jets, and the structure is a sheet of paper; the actuator controllers being responsive to price information to control the applied forces of the air jets to collectively promote movement of the sheet of paper from a first position to the second position in a paper path.

Claim 12: The distributed market based control assembly for a mobile structure of claim 4, wherein the mobile structure is a robotic arm formed by struts interconnected by rotational elements; wherein the actuator controllers responsive to price information control the applied forces of the multiple actuators to collectively promote movement of at least one of the struts from a first position to a second position.

Claim 13: A market based control system for controlling movement of a structure comprising:

multiple producing units for applying forces to the structure to effect the movement;

multiple consuming units for sensing the movement of the structure; and

an electrical conductor connecting the multiple producing units to the multiple consuming units; operation of each of the multiple producing units and the multiple consuming units causing an analog fluctuation in an electrical characteristic of the

conductor; the electrical conductor transmitting and receiving market price information encoded as measurable analog fluctuations in the electrical characteristic of the conductor; operation of the producing units to effect movement of the structure being determined in response to the market price information.

Claim 14: The distributed market based control assembly of claim 1 for applying a force to a structure, wherein the price information is a continuously provided electrical signal; the marketwire immediately transmitting changes in price information to the actuators.

Claim 15: The distributed market based control assembly for a mobile structure of claim 4 further including multiple sensors, wherein each actuator controller is connected to a sensor by the marketwire;

wherein the analog fluctuation in the electrical characteristic of the marketwire caused by the input measurement produced by each sensor provides a demand level for applied forces to be produced by the actuators on the structure; the demand level being a component of the price information on the marketwire;

wherein the analog fluctuation in the electrical characteristic of the marketwire caused by the applied forces produced by the actuators on the structure provides a supply level for input measurements produced by the sensors; the supply level being a component of the price information on the marketwire; and

wherein operation of the actuators and the sensors is a function of the demand and supply levels seeking equilibrium.

EVIDENCE APPENDIX

Attached hereto are copies of US 6,560,493 and non-patent literature publication by Guenther et al., "Controls for unstable structures," in *Proceedings of Smart Structures and Materials: Mathematics and Control in Smart Structures*, SPIE, San Diego, CA, 1997, v. 3039, pp. 754-763.

These documents were submitted during prosecution, and are referenced in the Arguments herein. Copies are provided for the convenience of the Board.

RELATED PROCEEDINGS APPENDIX

U.S. Patent 6, 915,267 (Application No. 09/404,692) was appealed to the Board of Patent Appeals and Interferences in October 2002. The Board rendered a decision on November 20, 2004. A copy of the decision follows.

~~AHM~~ 9961206

The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 22

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte WARREN B. JACKSON, DAVID K. BIEGELSEN, TAD H. HOGG, CHEE WE NG, ANDREW A. BERLIN, KOENRAAD F. VAN SCHUYLENBERGH, and CARLOS MOCHON

Appeal No. 2004-1981
Application No. 09/404,692

ON BRIEF

Before RUGGIERO, GROSS, and LEVY, Administrative Patent Judges.

LEVY, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 1-10, which are all of the claims pending in this application.

BACKGROUND

Appellants' invention relates to distributed control of non-linear coupled systems with a single output. An understanding of

Bd. Decision - Exam Reversed / NR

the invention can be derived from a reading of exemplary claim 1, which is reproduced as follows:

1. A control method for non-linear coupled systems of producing units having a single consumer output, the method comprising the steps of

setting each producing unit to have an output responsive to a continuously provided analog signal representative of a market price,

connecting each producing unit to a marketwire carrying the analog signal, with the changes in the analog signal on the marketwire representing changes in the market price and dependent upon the output response of each producing unit.

The prior art reference of record relied upon by the examiner in rejecting the appealed claims is:

Clearwater	5,394,324	Feb. 28, 1995

Claims 1-10 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Clearwater.

Rather than reiterate the conflicting viewpoints advanced by the examiner and appellants regarding the above-noted rejection, we make reference to the examiner's answer (Paper No. 20, mailed February 6, 2004) for the examiner's complete reasoning in support of the rejection, and to appellants' brief (Paper No. 19, filed December 22, 2003) for appellants' arguments thereagainst. Only those arguments actually made by appellants have been considered in this decision. Arguments which appellants could

have made but chose not to make in the brief have not been considered. See 37 CFR 41.37(c).

OPINION

In reaching our decision in this appeal, we have carefully considered the subject matter on appeal, the rejection advanced by the examiner, and the evidence of anticipation relied upon by the examiner as support for the rejection. We have, likewise, reviewed and taken into consideration, in reaching our decision, appellants' arguments set forth in the brief along with the examiner's rationale in support of the rejection and arguments in rebuttal set forth in the examiner's answer.

Upon consideration of the record before us, we reverse, essentially for the reasons set forth by appellants. We begin with claim 1.

To anticipate a claim, a prior art reference must disclose every limitation of the claimed invention, either explicitly or inherently. In re Schreiber, 128 F.3d 1473, 1477, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997). As stated in In re Oelrich, 666 F.2d 578, 581, 212 USPQ 323, 326 (CCPA 1981) (quoting Hansgirg v. Kemmer, 102 F.2d 212, 214, 40 USPQ 665, 667 (CCPA 1939)) (internal citations omitted):

> Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.

The examiner's position is set forth on pages 3-5 of the answer. Appellants assert (brief, pages 4 and 5) that Clearwater fails to teach two elements of the claimed invention. Firstly, appellants assert (brief, page 4) Clearwater does not teach or suggest[1] the claimed marketwire element. Appellants argue (id.) that Clearwater does not teach "that it is the same control signal or circuit that goes to each of the producing units and consuming units." Appellants further argue (brief, page 5) that "the signal provided in Clearwater is a control signal that does not inherently represent a market price." Secondly, appellants assert (brief, page 5) that Clearwater fails to teach a producing unit that is itself responsive to a market price signal. Appellants argue that in the system of Clearwater, the auction controller determines the market price and then sends a signal to the producing unit, rather than the producing unit itself responding to the market price.

The examiner responds (answer, page 12) that the first element, the marketwire, is disclosed by the "compound signals

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[1] Appellants' assertion regarding "suggestions" of Clearwater are misplaced as the claims have not been rejected under 35 U.S.C. § 103(a).

from the multiple thermostats." The examiner argues (answer, page 13) that the independent claims do not "specifically define how the marketwire signal is routed to and from the producing units and the consuming units." The examiner further argues (id.) that the market price is continuously present because Clearwater discloses that the signals from the thermostats contain both a volume and price component. The examiner asserts (answer, page 14) that Clearwater teaches the second element, a producing unit responsive to a market price, because "[t]he controller of Clearwater merely aggregates the signals from the multiple thermostats and provides this aggregate signal to the producing unit."

From our review of Clearwater, we find that Clearwater discloses (col. 1, lines 10-12) "a method and apparatus for efficiently distributing a resource based on a computerized auction." Clearwater further discloses (col. 4, lines 28-30) that "[t]he signal generated by each of the microprocessors is classified as either a buy bid or a sell bid." Clearwater also teaches (col. 6, lines 8-10 and lines 18-20) that the "respective buy bids and sell bids are plotted to form a demand curve 60 and a supply curve," and that the final auction price is the "point where the supply curve 62 meets the demand curve." Using this

calculated price (col. 6, lines 48-50), "the central workstation 50 (auctioneer) transmits a signal to each respective room taking place in a consummated sale." Finally, Clearwater discloses (col. 7, lines 52-55) that "should there be a net selling or buying of a resource, such as cold air, the total amount of temperature supplied by the HVAC plant (or other resource supplier) can be adjusted."

From this disclosure of Clearwater, we find, for the reasons which follow, that Clearwater does not teach the first element at issue, the marketwire, as asserted by the examiner. We agree that in appellants' claims 1, 5 and 8, (brief, page 4) "the same control signal and/or circuit represented by the marketwire is connected to each of the producing units and consuming units." Therefore, the disclosure in Clearwater of control signals being sent from the central workstation and thermostats during the auction process does not teach the marketwire. We also agree with appellants (brief, page 5) that "the signal provided in Clearwater is a control signal that does not inherently represent a market price," because the signals sent by the thermostats in Clearwater represent buy and sell bids for a particular room. These bids do not represent the market price, but rather are used by the central controller in the

auction process to determine the market price. Therefore, we find that Clearwater fails to teach the marketwire element as recited in claim 1.

We find that Clearwater also does not teach the second element at issue, a producing unit that is itself responsive to a market price signal. Clearwater discloses how the central controller calculates the auction price based on the buy and sell bids, and from this disclosure, we do not agree with the examiner (answer, page 14) that "[t]he controller of Clearwater merely aggregates the signals from the multiple thermostats and provides this aggregate signal to the producing unit." In Clearwater, the resource supplier adjusts its output in response to a signal from the central controller. This signal is not "representative of the market price," as recited in claim 1. We therefore agree with appellants (brief, page 6) that "there is no suggestion from Clearwater of the producing units having the ability to interpret a market price."

From all of the above, we find that the examiner has failed to establish a prima facie case of anticipation of claim 1. Accordingly, the rejection of claim 1, and dependent claims 2-4, is reversed. As independent claims 5 and 8 recite "providing producing units connected to a marketwire," the rejection of

claims 5 and 8, and dependent claims 6, 7, 9, and 10, is also reversed.

CONCLUSION

To summarize, the decision of the examiner to reject claims 1-10 under 35 U.S.C. § 102(b) is reversed.

REVERSED

Joseph F. Ruggiero

JOSEPH F. RUGGIERO
Administrative Patent Judge

Anita Pellman Gross

ANITA PELLMAN GROSS
Administrative Patent Judge

Stuart S. Levy

STUART S. LEVY
Administrative Patent Judge

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Controls for unstable structures

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ABSTRACT

We study the behavior of several organizations for a market based distributed control of unstable physical systems and show how a hierarchical organization is a reasonable compromise between rapid local responses with simple communication and the use of global knowledge. We also introduce a new control organization, the multihierarchy, and show that it uses less power than a hierarchy in achieving stability. The multihierarchy also has a position invariant response that can control disturbances at the appropriate scale and location.

Keywords: distributed control organizations, smart matter, multiagent systems

1. INTRODUCTION

Embedding microscopic sensors, computers and actuators into materials allows physical systems to actively monitor and respond to their environments in precisely controlled ways. This is particularly so for microelectromechanical systems (MEMS)[1, 2, 6] where the devices are fabricated together in single silicon wafers. Applications include environmental monitors, drag reduction in fluid flow, compact data storage and improved material properties.

In many such applications the relevant mechanical processes are slow compared to sensor, computation and communication speeds. This gives rise to a *smart matter* regime, in which control programs can execute many steps within the time needed for responding to mechanical changes. A key difficulty in realizing smart matter's potential lies in the design of the control programs. This is because one needs to robustly coordinate a physically distributed, real-time response, to a system with many elements that can exhibit failures, delays and a limited ability to accurately model the system's behavior in an unpredictable environment. These constraints limit the effectiveness of conventional control algorithms, which rely on a single global processor with rapid access to the full state of the system and detailed knowledge of its behavior.

A robust approach to controlling such systems uses a collection of autonomous agents, each of which can deal with a limited aspect of the overall control problem. Individual agents can be associated with each sensor or actuator in the material. This leads to a community of computational agents which, in their interactions, strategies, and competition for resources, resemble natural ecosystems[14], and which can be used to control distributed systems[10].

Multiagent systems have been extensively studied in the context of distributed problem solving[4, 7, 16]. They have also been applied to problems involved in acting in the physical world, such as distributed traffic control[18].

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flexible manufacturing[23], the design of robotic systems[19, 26], and self-assembly of structures[21]. However, the use of multiagent systems for controlling smart matter is a challenging new application due to the very tight coupling between the computational agents and their embedding in physical space. Specifically, in addition to computational interactions between agents from the exchange of information, there are mechanical interactions whose strength decreases with the physical distance between them.

In this paper we study the effect that different control organizations have on achieving stable behavior of an intrinsically unstable dynamical system. This is a particularly challenging problem, for in the absence of controls, the physics of an unstable system will rapidly drive it away from the desired configuration. That is the case, for example, of a structural beam whose load is large enough to cause it to buckle and break. In such cases, weak control forces, if applied properly, can counter departures from the unstable configuration while they are still small. Successful control in this case not only leads to a virtual strengthening of the material but also to rapid changes of the system into other desired configurations.

The paper is organized as follows. We first introduce the unstable physical system that we attempt to control. We then describe a market system for trading power among actuators that can provide distributed control in the face of local failures and limited information about the state of the system. Finally we analyze the performance of several control organizations of this multiagent system and compare their power needs in order to achieve a desired level of control. We then show how a particularly novel structure, the multihierarchy, can achieve desirable control levels while using less power than other organizations.

2. SYSTEM DESCRIPTION

The system we studied consists of n mass points connected to their neighbors by springs. In addition, a destabilizing force proportional to the displacement acts on each mass point. This models the behavior of unstable fixed points: the force is zero exactly at the fixed point, but acts to amplify any small deviations away from the fixed point. This system can be construed as a linear approximation to the behavior of a variety of dynamical systems near an unstable fixed point. In the absence of control, any small initial displacement away from the fixed point grows rapidly.

The dynamical behavior of the chain is described by

1. the number of mass points: n
2. spring constants: k
3. a destabilizing force: f
4. a damping coefficient: g

and the elements have unit mass. We assume that sensors and actuators are embedded in this system at various locations. Associated with these devices are computational agents that use the sensor information to determine appropriate actuator forces. The overall system dynamics can be viewed as a combination of the behavior at the location of these agents and the behavior of the material between the agent locations. The dynamics for the latter consists of high frequency oscillations that are not important for the overall stability[11] of the system. This is because stability is primarily determined by the behavior of the lowest frequency modes. We assume that there are enough agents so that their typical spacing is much smaller than the wavelengths associated with these lowest modes. Hence, to focus on the lower frequency dynamics it is sufficient to characterize the system by the displacements at the locations of the agents only. In this case, the high-frequency dynamics of the physical substrate between agents does not significantly affect overall stability. Instead, the substrate serves only to couple

the agents' displacements. The resulting dynamics of the unstable chain is given by:

$$\begin{aligned}\frac{dx_i}{dt} &= v_i \\ \frac{dv_i}{dt} &= k(x_{i-1} - x_i) + k(x_{i+1} - x_i) + f x_i - g v_i + H_i\end{aligned} \tag{1}$$

where x_i is the displacement of mass point i, v_i is the corresponding velocity, and $x_0 = x_{n+1} = 0$ is the boundary condition. The H_i term in Eq. (1) is the additional control force produced by the actuator attached to mass point i. We assume that the magnitude of this control force is proportional to the power P_i used by the actuator and we use a unit proportionality factor.

For this system. the control problem consists in determining how hard to push on the various mass points to maintain them at an unstable fixed point. Solving this problem can involve various goals, such as maintaining stability in spite of perturbations typically delivered by the system's environment, using only weak control forces so that the actuators are easy and cheap to fabricate. continuing to operate even with sensor noise and actuator failures, and being able to program the system without requiring a detailed physical model.

3. USING MARKETS FOR DISTRIBUTED CONTROL

While in principle an omniscient central controller with a perfect system model and unlimited computational capability could optimally control it, in practice such detailed knowledge of the system is seldom available. This is especially true in the case of mass production of smart materials, where manufacturing tolerances and occasional defects will cause the physical system to differ somewhat from its nominal specification. Instead, partial information about local changes in the variables is the only reliable source that can be used for controlling smart matter. In particular, price mechanisms perform well compared to other feasible alternatives[5, 15] for a variety of multiagent tasks. It is thus of interest to see how they perform in the new context of multiagent control of smart matter.

Computational markets can successfully coordinate asynchronous operations in the face of imperfect knowledge and changes in the environment[3, 13, 17, 22, 24, 25]. As in economics, the use of prices provides a flexible mechanism for allocating resources, with relatively low information requirements[9]: a single price summarizes the current demand for each resource.

In the market control treated here, actuators, or the corresponding mass points to which they are attached, are treated as consumers. The external power sources are the producers and as such are separate from consumers. All consumers start with a specified amount of money and all the profit that the producers get from selling power to consumers is equally redistributed to the consumers. This funding policy implies that the total amount of money in the system will stay constant.

In the spirit of a smart matter regime, where control computations are fast compared to the relevant mechanical time scales, we assume a market mechanism that rapidly finds the equilibrium point where overall supply and demand are equal. This equilibrium determines the price and the amount of power traded. Each actuator gets the amount of power that it offers to buy for the equilibrium price and uses this power to push the unstable chain.

Each consumer buys an amount of power, P_i, that depends on its associated utility function, U_i, which reflects a trade-off between using power to act against a displacement and the loss of wealth involved. While a variety of utility functions are possible, a particularly simple one for agent i, expressed in terms of the price

of the power, p, and the agent's wealth, w_i, is:

$$U_i = -\frac{1}{2w_i}pP^2 + bP|X_i| \tag{2}$$

where

$$X_i = \sum_{j=1}^{n} a_{ij}x_j \tag{3}$$

is a linear combination of the displacements of all mass points that provides information about the chain's state and represents the underlying organizational structure of the control method. The parameter b determines the relative importance to an agent of responding to displacements compared to conserving its wealth for future use.

All the actuators push so as to reduce the value of X_i. We also use an ideal competitive market in which each consumer and producer acts as though its individual choice has no affect on the overall price, and agents do not account for the redistribution of profits via the funding policy. Thus the consumer's demand function is obtained by maximizing its utility function as a function of power, which yields

$$P_i(p) = b|X_i|\frac{w_i}{p} \tag{4}$$

This demand function causes the agent to demand more power when the displacement it tries to control is large. It also reflects the trade-off involved in maintaining wealth: demand decreases both with increasing price as well as when agents have little wealth. The overall demand function for the system is just the sum of these individual demands, giving

$$P^{\text{demand}}(p) = \frac{b}{p}\sum_{i=1}^{n}|X_i|w_i \tag{5}$$

As to the functional form of the supply function, each producer tries to maximize its profit ρ given by the difference between its revenue from selling power and its production cost $C(P)$: $\rho = pP - C(P)$. To provide a constraint on the system to minimize the power use, we select a cost function for which the cost per unit of power, $C(P)/P$, increases with the amount of power required. A simple example of such a cost function is given by

$$C(P) = \frac{1}{2a}P^2 \tag{6}$$

with the parameter a reflecting the relative importance of conserving power and maintaining stability. Similarly, we obtain the producer's supply function by maximizing its profit, which gives:

$$P(p) = ap \tag{7}$$

For simplicity, we assume that all producers have the same cost, so that the overall supply function is

$$P^{\text{supply}}(p) = nap \tag{8}$$

From this, we can obtain the price and amount of traded power as the point where the overall demand curve intersects the overall supply curve. Specifically, the price at which power is traded is given by $P^{\text{demand}}(p) = P^{\text{supply}}(p)$. For our choices of the utility and cost functions, this condition can be solved analytically to give

$$p_{trade} = \sqrt{\frac{b}{na}\sum_{i=1}^{n}|X_i|w_i} \tag{9}$$

Given this equilibrium price, agent i then gets an amount of power equal to $P_i(p_{trade})$ according to Eq. (4).

The final aspect of the market dynamics is how wealth changes with time. Using a funding policy such that all expenditures are returned equally to the agents in the system gives a dynamical equation of the form

$$\begin{aligned}\frac{dw_i}{dt} &= -pP_i(p) + \frac{1}{n}pP^{\text{demand}}(p)\\ &= -b|X_i|w_i + \frac{b}{n}\sum_{j=1}^{n}|X_j|w_j\end{aligned} \tag{10}$$

This model establishes a particular multiagent control method. Its performance will depend on the organizational structure through the choice of the quantity that the agents respond to i.e., the combinations of displacements of individual elements, X_i.

4. MARKET ORGANIZATIONS

We now determine the role that the underlying organizational structure of the market plays in the performance of the control system. Interpreting the a_{ij}'s in Eq. (3) as a description of how important it is for agent i (actuator) to get information from agent j (sensor) when deciding how much power to request, allows us to study different organizations by changing the structure of this interaction matrix. In what follows we will focus on 4 different organizational structures: (1) local, (2) global, (3) hierarchical and (4) multihierarchical[11]. These structures are represented by interaction matrices shown in Fig. 1. In the case of a local structure every agent uses only his own information, i.e., $a_{ij} = \delta_{ij}$ which is 1 when $i = j$ and zero otherwise. A global structure allows all agents to access all of the available sensor information. Thus the matrix elements, a_{ij}, for the global structure are calculated by fitting the unstable modes to the chain's state using the sensor data of all agents.

In the case of both a hierarchical and a multihierarchical structure, the control system is divided into a number of levels, with "managers" at each level responsible for communicating with subordinate agents below and superior agents above. In terms of information flow, the managers can aggregate the states of lower level agents and make this aggregate information available to agents in other parts of the system. In this way, each agent has, in addition to its own state, some averaged information about the state of the system on larger scales. Hierarchical organizations for control have been used in other contexts, such as controlling vibrations in a stable system[8, 12].

The multihierarchy consists of a structure of interleaved hierarchies having the advantage of solving the difficulty associated with the hierarchy of occasional mismatches between the physical and organizational distances between agents. In particular, agents near an organizational boundary of a high level part of the hierarchy require many levels in the hierarchy to communicate with some of their immediate physical neighbors. This introduces an inhomogeneity in the response of the hierarchical system in that some medium-scale perturbations can be controlled entirely within a single part of the hierarchy while others, crossing these high level boundaries, require additional levels of communication and aggregation of information.

We now compare the performance of these structures in terms of overall used power, average displacement and time to reduce the average displacement below a given value.

We studied[a] a chain composed of 27 mass points, all of them having unit mass and connected by springs with a spring constant of value 1 and damping coefficient 0.1. The destabilizing force coefficient is 0.05, which is sufficient to make the system unstable when there is no control force. Specifically, this makes only the lowest

[a] We used a standard ordinary-differential-equation solver for integrating the equations of motion[20].

mode of the system unstable. All agents start with an initial wealth of 50 money units. In the cost function of Eq. (6) we use $a = 0.05$. In order to compare the 4 structures in a fair way, we ran several simulations for each organization and searched for the b value in Eq. (2) that results in successful control with the least amount of power used. This results in using $b = 3.9 \times 10^{-5}$, 3.1×10^{-5}, 5.0×10^{-5}, 3.7×10^{-5} for the local, global, hierarchical and multihierarchical structures, respectively. This allows us to compare the performance of the different structures in a fair way.

For definiteness, we chose an initial condition where a single element in the middle of the chain had a unit displacement and all other elements of the chain have no displacement. This initial condition includes a contribution from all modes of the system, specifically including the lowest mode, which is unstable when there is no control force. Since in this case there is a single unstable mode, the calculation of the a_{ij}'s for the global, hierarchical and multihierarchical structure are only based on a fit of the first unstable mode. Fig. 1 shows the interaction matrices corresponding to the different structures that we studied.

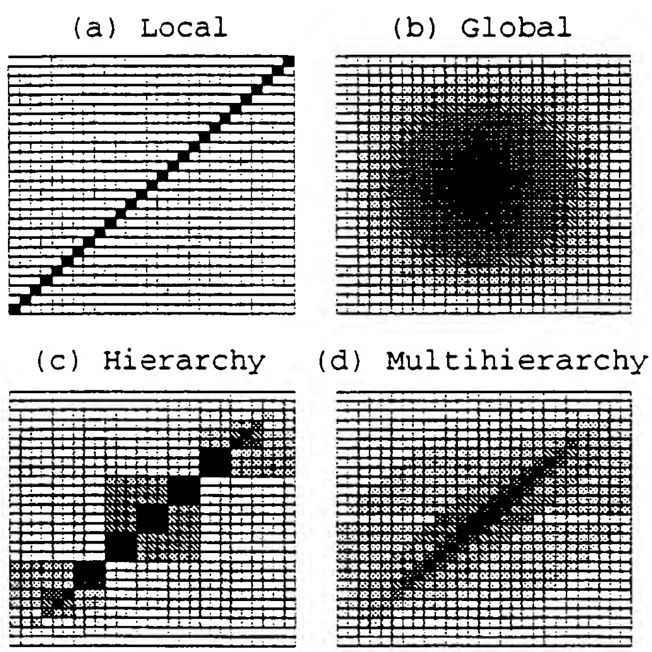

Fig. 1. Interaction matrices of four different organizations. For each organization's plot, starting in the lower-left corner, columns represent agent i and rows represents agent j, with i and j going from 1 to 27. The shade in each small square characterizes the interaction between agent i and agent j at that position. Black represents a strong connection, and gray a weaker one. (a) corresponds to a local structure where every agent listens only to itself and ignores all other agents in the system. The interaction with other agents is only mediated by the springs that connect elements. (b) depicts the global case, whereas (c) and (d) correspond to a hierarchical and a multihierarchical organization with 3 levels and a branching ratio of 3.

The performance of these organizations when confronted with reducing the initial value displacement is shown in Fig. 2. As can be seen, the time evolution of the average displacement differs slightly for different organizations.

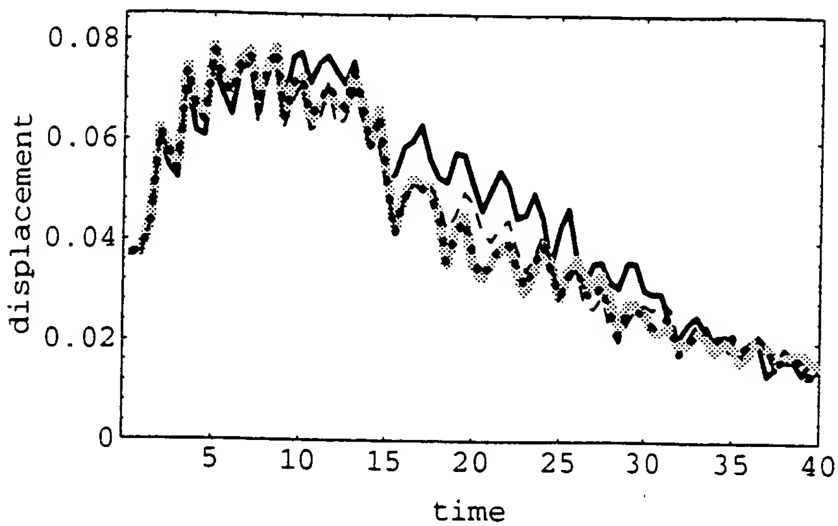

Fig. 2. Average displacements of the unstable chain when using different organizational control structures. The solid, black curve represents the local structure. The global structure is represented by the solid, gray curve and the dashed and the dotted curves present the hierarchy and the multihierarchy, respectively.

On the other hand, since power is the good traded in the market one expects that the different organizational structures will exhibit different behavior in their power usage in Fig. 3. As one could have assumed, the global control uses less power than the local control whereas the hierarchical and multihierarchical structure lie somewhere between in their power use. Notice that the global structure needs less power than the local one, except for a small time at the beginning, and on average the multihierachy uses less power than the hierarchy.

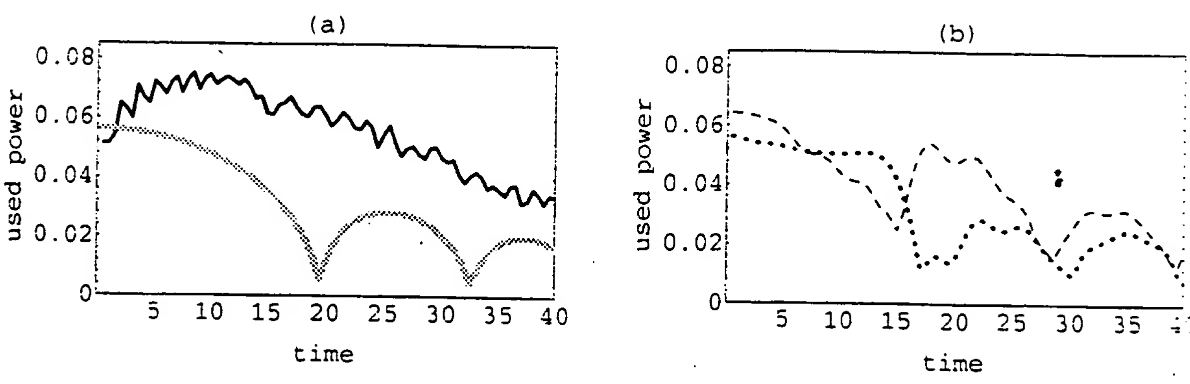

Fig. 3. Time evolution of the power used by different control organizations. In a) we compare the power usage of a local (solid, black) and a global (solid, gray) organization. In b) we compare the hierarchical (dashed) with the multihierarchical (dotted) organization.

Since the power usage curves have different functional forms, for purposes of comparison it is more convenient to plot the overall power used to push the average displacement of the chain below a given threshold value. This is shown in Fig. 4. The x-axis denotes the threshold value for the average displacement and the y-axis corresponds to the overall power needed to reduce the average displacement below that value. As can be seen, the global structure (solid, gray curve) performs best, although the multihierarchy (dotted curve) shows almost

the same performance. The local organization (solid, black curve) uses the most power whereas the hierarchical structure (dashed) lies somewhere between.

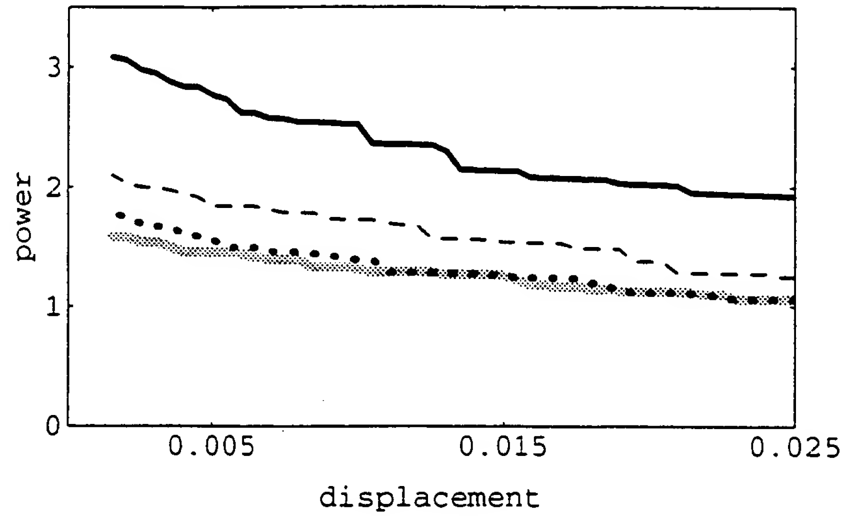

Fig. 4. Overall power usage for the different organizational structures to reduce the average displacement below a given threshold that is given by the value on the x-axis.

5. DISCUSSION

In this paper we presented a novel mechanism for controlling unstable dynamical systems that uses a multiagent approach combined with a market mechanism for trading power among actuators. This allows for distributed control of an unstable system in spite of limited information about its dynamical state. We also studied the effectiveness of different market organizations in achieving control, and we compared their relative performance. While we noticed that the average excursions of the controlled system do not depend significantly on the control organization, the power usage does. In particular a global control organization uses the least amount of power to control the unstable system while also being capable of reducing the average displacement of the chain. This stems from the fact that the agents have access to global information while using a model that describes the physical connections within the system. While the global approach is appropriate for small systems with a well defined dynamical model, it becomes increasingly difficult to apply it to larger systems where the available information about the system's state might be limited.

This led to consider alternative organizations, such as a local control and more interconnected ones, such as hierarchies and multihierarchies. We then showed that the use of hierarchical and multihierarchical structures lead to a better performance than using a local structure, in terms of the amount of power needed for controlling the unstable system is needed. Moreover a multihierarchy control organization uses less power than the simple hierarchical structure. This is due to the position invariant response of a multihierarchy, which can therefore control disturbances at appropriate scales. This difference may become even more significant if each level of managers introduces some delay in communicating the aggregate information.

An extension of this research that we are now pursuing consists in the use of a learning mechanism that can improve the performance of the system by changing the market organization in time. This would allow the system to dynamically find those structures most suited for particular situations and to change them as necessary. Equally important, it could lead to the discovery of novel organizational structures that cannot be anticipated from a priori analysis of systems that by their very nature are imperfect.

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